

**AUDIO TO VIDEO TIMING MEASUREMENT
FOR MPEG TYPE TELEVISION SYSTEMS**

4 This application is a Continuation In Part to S/N 09/119,524 filed 07/21/98 which is a
5 division of S/N 08/620,126 filed 03/21/96 which receives priority from provisional application
6 60/008,309 filed December 7, 1995, which applications are incorporated herein in their entirety
7 and for all purposes as if they had been set forth in detail.

8 The examiner's attention is called to incorrectly published U.S. Patent 5,847,769 which is
9 related to the present application by virtue of common application 08/620,126. The '769 patent
10 was withdrawn from issue. Despite the fact of the patent being withdrawn from issue it was
11 nevertheless published by the Patent Office. Applicant is of the belief that this mistakenly
12 published patent does not constitute prior art, and is not available in respect to any double
13 patenting matter or the like, but brings it to the attention of the examiner out of applicant's duty of
14 candor.

BACKGROUND OF THE INVENTION

17 The invention relates to measuring, maintaining and correcting synchronization between two
18 signals which suffer varying relative delays during transmission and/or storage, and in particular to
19 measuring the relative delay between multiple audio signals and an associated video signal of a
20 television type program which is compressed via MPEG or other compression method for
21 transmission and/or storage.

1 1. FIELD OF THE INVENTION

2 The present invention relates to the field of transmitting and storing multiple electronic
3 signals where synchronization of the signals is of concern. When such transmitting and storing are
4 of a nature which makes the corresponding receiving and recovering of said signals subject to
5 timing errors resulting from differing amounts of processing delays the present invention is useful
6 in measuring the relative timing errors or delays between signals with such delay measurement
7 being used as a meter of quality of the transmitting and storing and for maintaining or correction
8 of relative delays between such signals.

9
10 2. DESCRIPTION OF RELATED PRIOR ART

11 It is known in the television signal transmission field to measure and correct audio to video
12 timing errors by measuring the delay which a video signal experiences and using that measurement
13 to delay a companion audio signal by a corresponding amount.

14 U.S. Patent 4,313,135 by the present inventor shows to compare relatively undelayed and
15 delayed versions of the same video signal to provide a delay signal responsive to the delay thereof
16 and to couple that delay signal to a variable audio delay to cause the audio delay to delay the
17 companion audio signal by a corresponding amount.

18 U.S. Patents 4,665,431 and 5,675,388 by the present inventor show transmitting an audio
19 signal as part of a video signal so that both the audio and video signals experience the same
20 transmission delays thus maintaining the relative synchronization therebetween.

21 U.S. Reissue Patent RE 33,535 corresponding to 4,703,355 shows in the preferred
22 embodiment to encode in the vertical interval of a video signal, a timing signal derived from an

1 It is another object of the invention to provide a method of generating a marker in response
2 to a second signal which marker may be associated with a first signal in a fashion that said marker
3 is carried with said first signal through processing of said first signal.

4 It is still another object of the invention to provide a method of responding to a marker
5 which has been associated with a first signal and a marker which is provided in response to a
6 second signal whereby said markers may be utilized to determine the relative delay between said
7 first and second signals.

8 It is a further object of the invention to provide a marker in response to a signal wherein said
9 marker indicates the occurrence of particular characteristics of said signal.

10 It is a still further object of the invention to provide a system of measuring the relative delay
11 between an audio and a video signal in a television system wherein the audio and video signals are
12 subject to differing processing which creates unequal delays in said signals.

13 It is yet still a further object of the invention to provide a method of marking a first signal
14 which may be a video signal to allow relative delay measurement of said first signal and a second
15 signal which may be an audio signal after they have been processed, including use of a marker
16 generator responsive to the second signal to generate a marker upon the occurrence of one or more
17 particular characteristics of the audio, associating the marker with the video signal in a fashion
18 such that the marker will be carried with the video signal and not be adversely affected by the
19 subsequent processing thereof.

20 It is yet still another object of the invention to provide a relative delay measurement system
21 for measuring the relative delay between a plurality of signals including a first signal which is a
22 video signal and second signal which is an audio signal which signals experience unequal delays

1 due to processing thereof, the invention including use of a marker generator responsive to the
2 audio signal to generate a marker upon the occurrence of one or more particular characteristics of
3 the audio, associating the marker with the video signal in a fashion such that the marker will by
4 carried with the video signal but not be adversely affected by the subsequent processing thereof,
5 responding to the marker with the video signal after the processing to generate a first delayed
6 marker; generating a second delayed marker in response to the processed audio signal, comparing
7 the relative timing of the first and second delayed markers to determine the relative timing
8 between the processed audio and processed video signal.

9 The preferred embodiment of the invention may be used with a television signal. At the
10 transmitting location a marker is generated in response to the audio signal and is associated with
11 the video signal such that the marker is carried with the video signal in a fashion such that it will
12 not be lost or adversely affected by the expected processing of the video signal. The audio signal
13 and the marker associated video signal are stored, transmitted and/or processed and made available
14 at a later time thus becoming delayed video and audio signals.. A first delayed marker is recovered
15 from the delayed video signal and a corresponding second delayed marker is generated from the
16 delayed audio signal, with the two delayed markers compared to determine the relative delay
17 therebetween. This relative delay between these markers is responsive to and is a measure of the
18 delay between the delayed video signal and delayed audio signal.

19 Somewhat simplistically stated, the preferred embodiment of the invention operates by
20 generation of the marker at the transmit section, which may be thought of a marking the video at
21 the time of the occurrence of a known event in the audio signal. The time marker is associated
22 with the video signal such that it is carried in time with the video signal for all of the processing

1 which the video signal is to experience. After the video signal processing and any audio signal
2 processing, the same event in the audio is again marked in time, and the previously marked time
3 (relative to the video) is recovered or flagged in the received video. Since it is known that the
4 audio event and the marking of the video occurred (substantially) simultaneously at the transmit
5 location, the displacement between those events at the receive location is a measure of the audio to
6 video timing error, or the relative delay therebetween.

7 Generally, the present invention teaches measuring the relative delay between a plurality of
8 signals which have suffered differing delays due to transmission, storage or other processing. The
9 preferred embodiment of the invention includes the use of a marker which is generated in response
10 to a second signal and combined with a first signal in a manner which ensures that the marker will
11 not be lost in the expected processing of the first signal. Subsequently a first delayed marker is
12 generated in response to the marker associated with or recovered from the first signal, and a
13 second delayed marker is generated from the second signal. The first delayed marker and second
14 delayed marker are compared to determine a measure of the relative timing or delay between said
15 first signal and said second signal at said subsequent time.

16

17 BRIEF DESCRIPTION OF THE DRAWINGS

18 Figure 1 shows a block diagram of the preferred embodiment of the invention as used with a
19 television audio and video signal.

20 Figure 2 shows a block diagram of the marker generator 3 and 13 of the preferred
21 embodiment of the invention.

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DETAILED DESCRIPTION OF THE INVENTION

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2 In Figure 1 the preferred embodiment of the invention which is given by way of example, a
3 video signal 1 and an audio signal 2 are present at what will be referred to as the transmit location.
4 Either or both the video and audio signals may be in analog or digital, compressed or
5 uncompressed form, the many variations and versions of which are well known in the art. Further,
6 while the preferred embodiment is shown in respect to one video and one audio signal, it will be
7 appreciated from the teachings herein that the invention may be utilized and practiced with
8 multiple video and/or audio signals. In particular, by way of example the invention may be
9 practiced with video and stereo (2 channel), surround (4+ channel) or 5.1 channel audio systems as
10 are contemplated for the new U.S. digital and HDTV transmission standards. It is also noted that
11 the components of the invention may be implemented by analog, digital or software means or
12 combinations thereof.

13 A marker generator 3 is responsive to the audio signal, and may be responsive to the video
14 signal as indicated by the dashed line. In response to detecting the occurrence of one or more
15 particular feature or characteristic of the audio signal generates a marker. One of ordinary skill in
16 the art will recognize that element 44 of RE 33,535 may be utilized as element 3 herein. Other
17 constructions and operations of 3 will also will be known to one of ordinary skill from the present
18 teachings. The particular features, characteristics, occurrences or other event in the audio signal
19 which will result in the marker, will be referred to hereinafter as occurrences and the marker in its
20 various forms will sometimes be referred to simply as a marker, one of ordinary skill
21 understanding from the context and the teachings herein the specificity of the form or forms being
22 referred to.

1 which are configured to pass only audio within a range of frequencies as is well known in the art.

2 The output of each bandpass filter is coupled to a comparator 22a-h respectively. The comparators

3 include hysteresis or other threshold(s) and bipolar response characteristic so that if the positive or

4 negative half cycle of bandpassed audio out of the bandpass filter exceeds a threshold amount set

5 by the hysteresis, the output of the comparator is activated. Each comparator output is respectively

6 coupled to a timing duration circuit 23a-h. Each timing duration circuit also receives a reset signal

7 from the timing circuit 26. The timing circuit 26 provides signals to the parallel to serial converter

8 24 in addition to the reset signal provided to the timing duration circuits 23. Once the timing

9 duration circuit is reset, it inspects the output signal from its respective comparator 22. If the

10 output signal from 22 is activated for an established time duration indicating the presence of audio

11 frequencies within the corresponding bandpass filter range, the timing duration circuit sets its

12 output active and holds it active until the next reset signal. The outputs of all of the timing

13 duration circuits 23 are simultaneously latched into the parallel to serial circuit 24 upon command

14 from the timing circuit 26 and shortly thereafter the reset signal to 23 is generated. Also shortly

15 after latching, the bits latched into 24 are caused to be output in serial fashion as marker 25. The

16 net effect of the circuitry is to set a bit of the timing signal active corresponding to each of the

17 bandpass audio frequencies which was present during the time period from one reset signal to the

18 next, which corresponds to the time period from the generation of one marker to the next. The

19 timing circuit 26 is responsive to the video signal to set the desired time period between markers,

20 as well as to time the output of the marker 25 so that it is associated with the video signal at the

21 correct time. This action will ensure that the marker is placed at the desired position in the video

22 signal.

The bandpass filters are preferred to be selected to provide frequent outputs with the expected types of audio signals. For commercial television audio signals it has been found that bandpass filters with center frequencies of 25, 50, 150, 400, 1000, 2500, 6000, 15000 Hz and skirts of 6dB per octave work well. Other center frequencies and bandwidths may be chosen, and the number of filters changed, to facilitate expected audio signal frequency content. Ideally the frequencies would be chosen such that the lowest frequency filter has an output which is active or makes a change of state only once per period of the maximum expected delay differential of the audio and video signal. Alternatively, other audio characteristics may be relied on in the place of, or in addition to, the detection of energy at particular frequencies as described in respect to the preferred embodiment. Examples include, but are not limited to, impulse characteristics, amplitude characteristics, relationships between different frequency energies, relationships among and between different audio channels.

Another example of alternate audio characteristics which may be utilized for the marker is the particular audio sonic characteristics which are relied on for the audio compression. Because these characteristics are already detected in the compression circuitry the present invention may share circuitry thus resulting in lowered cost. Other sharing of circuitry with other functions may be possible depending on the particular signals and environment with which the invention is used.

18 While it has been described to utilize the marker generator with one audio signal in the
19 preferred embodiment, it will be understood that multiple audio signals may be accommodated,
20 with each having a corresponding marker which is associated with the video. Alternatively a
21 plurality of audio signals may be used to generate a lesser number or even one marker by various
22 techniques which include combining the plurality of audio signals before coupling to the marker

